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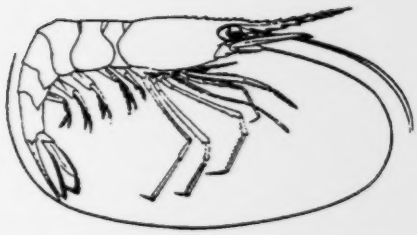
Quebec Region
Canadian Science Advisory Secretariat
Science Advisory Report 2010/008

ASSESSMENT OF SHRIMP STOCKS IN THE ESTUARY AND GULF OF ST. LAWRENCE IN 2009



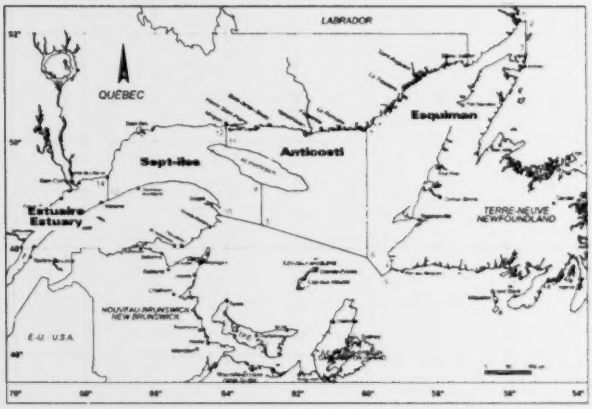


Figure 1. Shrimp fishing areas in the Estuary and Gulf of St. Lawrence.

Context

The northern shrimp (Pandalus borealis) fishery began in the Gulf of St. Lawrence in 1965. The exploitation is conducted by trawlers in four shrimp fishing areas (SFA): Estuary (SFA 12), Sept-Iles (SFA 10), Anticosti (SFA 9) and Esquiman (SFA 8) (Figure 1).

Shrimp fishing is regulated by a number of management measures, including the setting of total allowable catches (TAC) in the four areas. TAC-based management limits fishing to protect the reproductive potential of the population. The essential elements for the establishment of a precautionary approach were examined during a national DFO-Industry workshop held in 2008. Provisional reference points were adopted in order to initiate the development of a precautionary approach for the Gulf shrimp fishery.

The resource is assessed each year to determine whether changes that have occurred in the stock status necessitate adjustments to the conservation approach and management plan.

SUMMARY

- Landings totalled nearly 36,000 t in 2009 and were similar to those of 2008. Most of the stock abundance indicators for 2009 were close to or higher than the mean for the years 1990-2008 but some showed a decrease relative to 2007.

- The commercial fishery catch rate was similar to that of 2008 in Sept-Iles and Anticosti, decreased in Estuary and increased in Esquiman. The survey biomass index was similar to that of 2008 in all areas.

Canada

- The fishing effort and the exploitation rate index increased in Estuary and Sept-Iles but decreased in Anticosti and Esquiman. The exploitation rate index largely exceeded the mean in Estuary and reached the third highest value of the series. The index was close to the mean in the other areas.

- The summer male and female abundance indices estimated from the fishery and survey data, constitute the main indicators for the status of the stocks. In 2009, the combined male and female index was higher than the mean in all areas except in Estuary where it decreased by about 40% to reach a value below the mean. The index has a predictive value of the amount of females that will be available to the fishery and to the reproduction the following year.

- The comparison of the 2009 female index to the provisional reference points indicates that the abundance of females has stayed in the healthy zone for all areas except for Estuary where the index is in the precautionary zone. The female sizes were similar to the mean in Estuary and Sept-Iles but were still below the mean in Anticosti and Esquiman.

- The Sept-Iles, Anticosti and Esquiman stock status have been above the mean since 2003 and the female abundance is still in the healthy zone. In 2010, catches similar to those of 2009 should generate exploitation rates close to the mean. Consequently, the status quo is recommended for the 2010 TACs in these fishing areas.

- The Estuary stock status decreased below the mean in 2009, the exploitation rate increased well above the mean and the female abundance came down in the precautionary zone. Consequently, a 10 to 15% decrease of the TAC is recommended for this fishing area in 2010.

- The indicators for the Sept-Iles and Esquiman stocks seem however to indicate a decrease even if they are still in the healthy zone. It is thus important that the exploitation rates do not increase in order to help maintain these stocks in the healthy zone.

INTRODUCTION

Species Biology

The biology of shrimp has several particularities which in turn influence the exploitation strategy, fishery management and resource conservation.

Shrimp change sex over the course of their life cycle, achieving male sexual maturity at about two and a half, then becoming female between four and five years old. The females, which carry their eggs beneath the abdomen, are thus among the largest specimens in commercial catches; the males are smaller because they are younger. Mating takes place in the fall, and the females carry their eggs for eight months, from September until April. The larvae are pelagic when they hatch in the spring, but settle on the bottom by late summer. Shrimp migrations are associated with breeding (the egg-bearing females migrate to shallower water in winter) and feeding (at night, they leave the ocean floor to feed on small planktonic organisms). In general, shrimp are found throughout the Estuary and northern Gulf of St. Lawrence at depths of 150 m to 350 m.

Description of the Fishery

The number of active licences in the Estuary and the Gulf shrimp fishery in 2009 was about 150. The harvesters come from five provinces and seven First Nations. The fishery management measures include the imposition of a minimum mesh size (40 mm) and, since 1993, the compulsory use of the Nordmore grate, which significantly reduces groundfish by-catches. Shrimpers must also keep a log book, have their catches weighted by a dockside monitoring program and agree to have an observer on board upon request by the Department (5% coverage). The fishery opens on April 1st and closes on December 31st. The fishery has been managed by TAC since 1982, and the traditional fishermen have had individual quotas since the mid-1990s.

Landings of northern shrimp in the Estuary and Gulf of St. Lawrence have risen gradually since the fishery began. Landings rose from approximately 1,000 tons to 7,500 tons between the early and late 1970s, and to 15,000 tons by the late 1980s. They remained mostly stable between 1990 and 1995 (Figure 2). The TACs increased gradually beginning in 1996, and landings totalled over 23,000 tons by the late 1990s. TACs rose again in 2000, 2001 and 2004, and landings followed, totalling over 36,000 tons in 2004. The TAC had however been lowered in the Esquiman area in 2003 in order to reduce the exploitation rate. The TACs did not change in 2005, except in Esquiman where the TAC was increased by 10%. They remained stable in 2006 and 2007. In 2008 and 2009, they were increased relative to 2007 by 2.0 and 2.3% respectively. Preliminary statistics indicate that the Gulf landings were close to 36,000 tons in 2009.

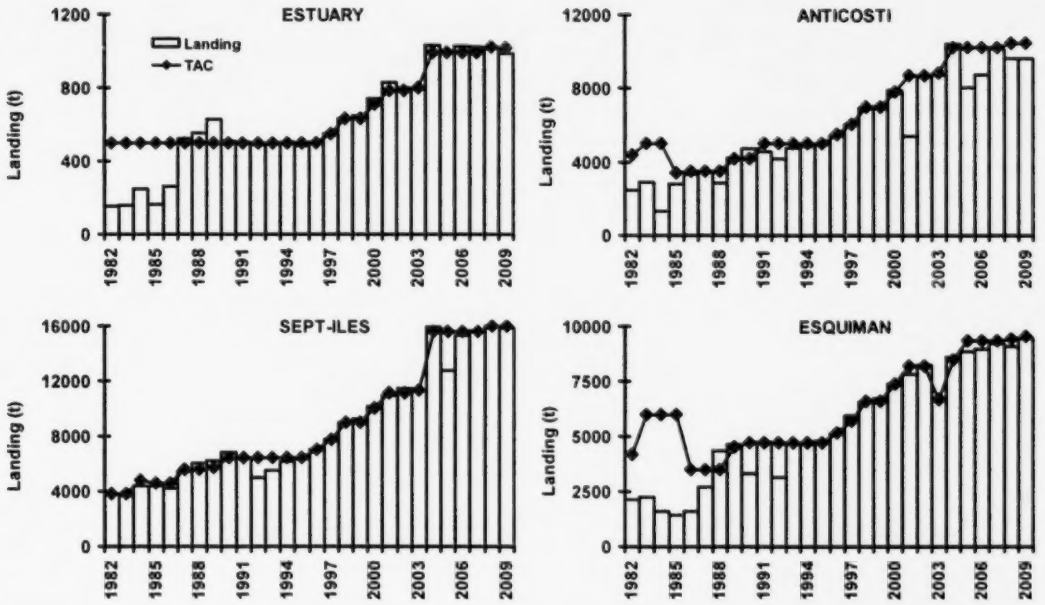


Figure 2. Landing and total of admissible catch (TAC) by fishing area and by year. The 2009 landing data are preliminary.

RESOURCE ASSESSMENT

The stock status is determined by examining a number of indicators from the commercial fishery and the research survey. The indicators are compared to the 1990-2008 mean in order to assess their trend over time.

The statistics from the commercial fishery (shrimper catch and effort) are used to estimate the fishing effort and to calculate catch rates in weight or in number. The data are standardized to take into account changes in fishing capacity and seasonal fishing patterns. The model used for the standardization explains more than 68% of the variability in the data. The commercial catch samples allow the estimation of the number of shrimp harvested by size classes and by sexual maturity stage.

A research survey is conducted every year in the Estuary and Gulf of St. Lawrence in August from a Departmental vessel. The *CCGS Alfred Needler* was used to do the survey from 1990 to 2003 and in 2005 while the *CCGS Teleost* has been used for the survey since 2004. Following a comparative fishing survey, the *CCGS Alfred Needler* catches were adjusted to match those that would have been made by the *CCGS Teleost*. Biomass indices are calculated using a geostatistical method. Survey catch samples provide abundance estimates of shrimp by size classes and by stage of sexual maturity.

Resource Status in 2009

There was no noticeable change in the distribution of fishing effort in 2009. The sectors that sustain fishing in the four areas have not changed in recent years and correspond to the spots where high concentrations of shrimp were observed during the survey (Figure 3). In 2009, the total number of fishing hours increased by 23% in Estuary and 11% in Sept-Iles but decreased by 2% in Anticosti and 8% in Esquiman.

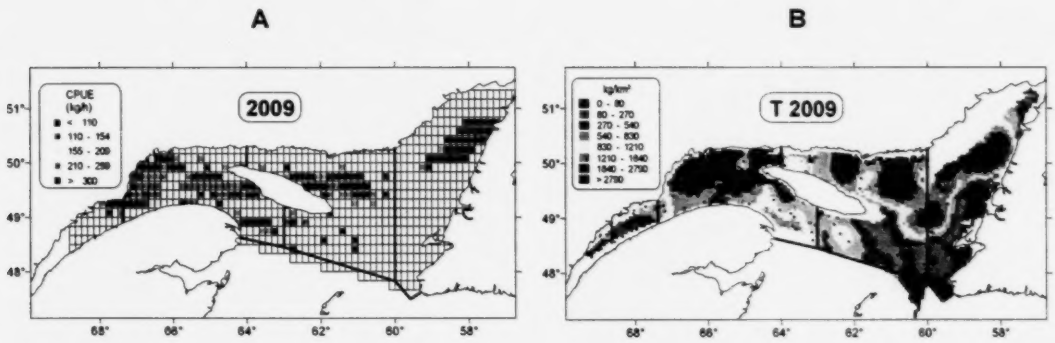


Figure 3. A) Spatial distribution of catch rates (CPUE) from the shrimp fishery in 2009. B) Spatial distribution of shrimp biomass estimated by kriging during the research survey in 2009.

The catch rate from the commercial fishery and the biomass index from the research survey are considered as good indicators of the size of the stocks. In 2009, the annual standardized catch rate from the commercial fishery was similar to that of 2008 in Sept-Iles and Anticosti, decreased in Estuary and increased in Esquiman (Figure 4A). The catch rates are higher than the mean except in Estuary where the rate is similar. In 2009, the biomass index from the research survey was similar to that of 2008 in all areas (Figure 4B). The biomass indices are similar to the mean in all areas.

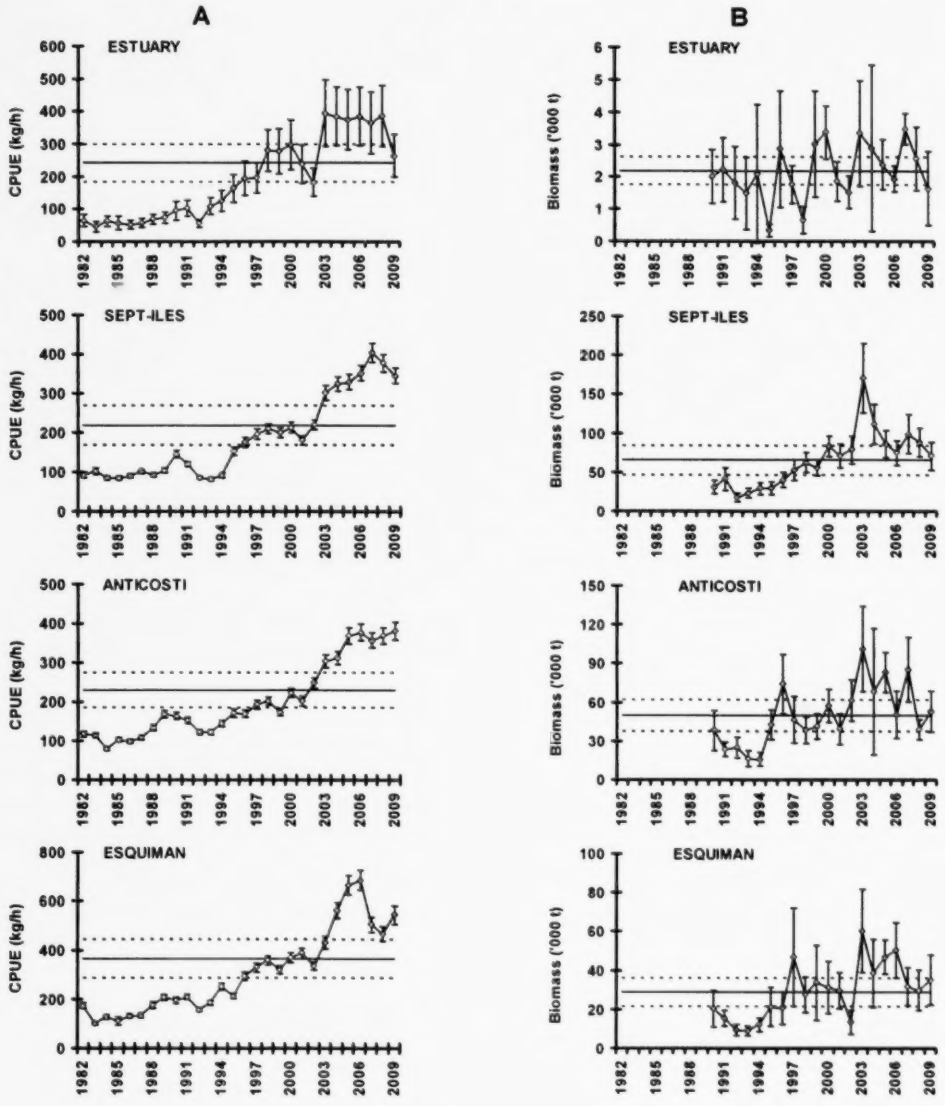


Figure 4. Indices for the size of the stock. A) Catch rate from the commercial fishery ± confidence interval (95%). B) Biomass index from the research survey ± confidence interval (95%). The full horizontal line represents the 1990-2008 mean ± 0.5 standard deviation.

An index of the exploitation rate is obtained by dividing the commercial catches in number by the abundance estimated from the research survey. This method cannot be used to estimate the absolute exploitation rate nor to relate it to target exploitation rates, but the method does make it possible to track relative changes in the exploitation rate over the years. The exploitation rate index increased in 2009 in Estuary and Sept-Iles but decreased in Anticosti and Esquiman (Figure 5). The index is situated close to the mean in all areas except in Estuary where the index is largely above the mean. The 2009 value represents the third highest value of the series.

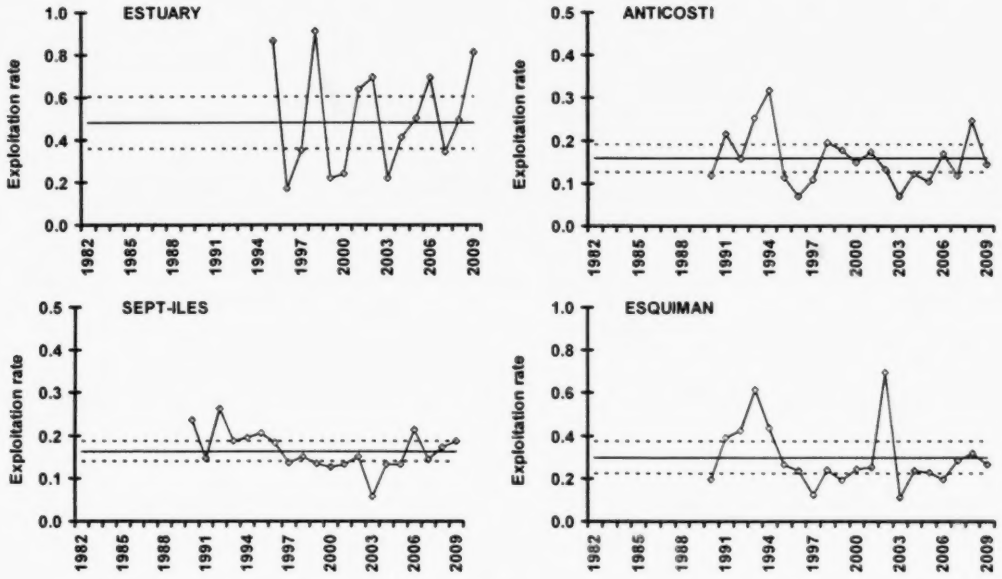


Figure 5. Indices of the exploitation rate. The full horizontal line represents the 1990-2008 mean ± 0.5 standard deviation.

The abundance of primiparous females which will recruit to the spawning stock a given year can be predicted from the abundance of males the preceding year. Similarly, the abundance of reproductive females which will hatch the larvae at spring can be predicted from the abundance of females the preceding year. The abundance indices for males and females are therefore good indicators of the quantity of females that will be available to the fishery and the reproduction the following year and constitute, when they are combined, the main indicator for the stock status.

The male and female combined indicator is calculated from the fishery data in summer (number per unit of effort for June, July and August) and from the survey data (abundance). Each index is first standardized relatively to the 1990-1999 period (annual value of the index divided by the 1990-1999 geometric mean). An index by sex is estimated by the mean calculated between the index from the fishery and the index from the survey. The combined index is obtained by calculating the mean between the indices estimated for each sex.

In 2009, the male and female combined index decreased by 37% in Estuary, 9% in Sept-Iles and 5% in Esquiman while it increased by 25% in Anticosti (Figure 6). The index was higher than the mean in all areas except in Estuary where the 2009 value decreased below the mean.

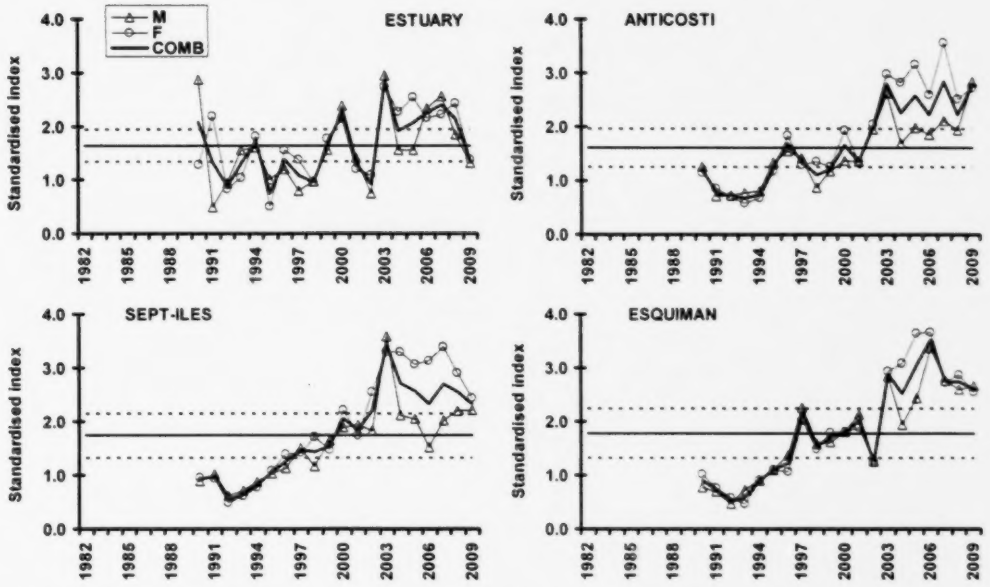


Figure 6. Standardized indices for males (M) and females (F) and, male and female combined index (COMB). The full horizontal line represents the 1990-2008 mean ± 0.5 standard deviation.

A national workshop was held in November 2008 on the development of precautionary approach frameworks for Canadian shrimp fisheries. The establishment of limit reference points and upper stock reference points delineating the healthy, cautious and critical stock status zones was discussed at the meeting. Provisional reference points based on female abundance were proposed for the Gulf of St. Lawrence fishery. The reference points were determined from the smoothed standardized mean index of the female abundance. The lowest observed value was used as the limit reference point and the upper stock reference was based on a reference period corresponding to the index appearing to plateau before increasing again.

The mean standardized index for female abundance in 2009 is compared to the provisional reference points to determine in which zone each of the four stocks is situated (Figure 7). In 2009, the indicator for the abundance of the spawning stock has maintained in the healthy zone in Sept-Iles, Anticosti and Esquiman but decreased in the cautious zone in Estuary. Between 2008 and 2009, the mean standardized index for females decreased by 43% in Estuary, 16% in Sept-Iles and 12% in Esquiman and increased by 8% in Anticosti.

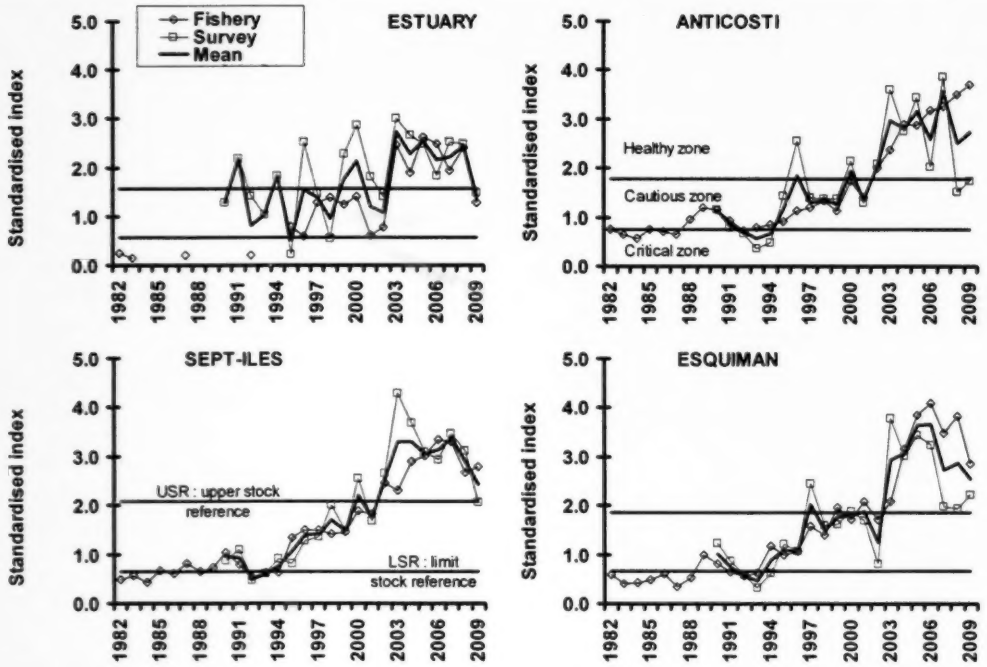


Figure 7. Standardized index for females from the fishery and from the survey and mean standardized index by fishing area and by year. The horizontal lines correspond to the provisional reference points (USR and LSR, see Sept-Iles panel) that delineate the healthy, cautious and critical zones (see Anticosti panel).

The variations in female sizes follow an east-west gradient, the smallest being observed in the Esquiman and the largest in the Estuary (Figure 8). In 2009, the mean size of females was similar to the mean in Estuary and Sept-Iles. The size remained below the mean in Esquiman and Anticosti and reached in 2008 or 2009, the lowest value of the series.

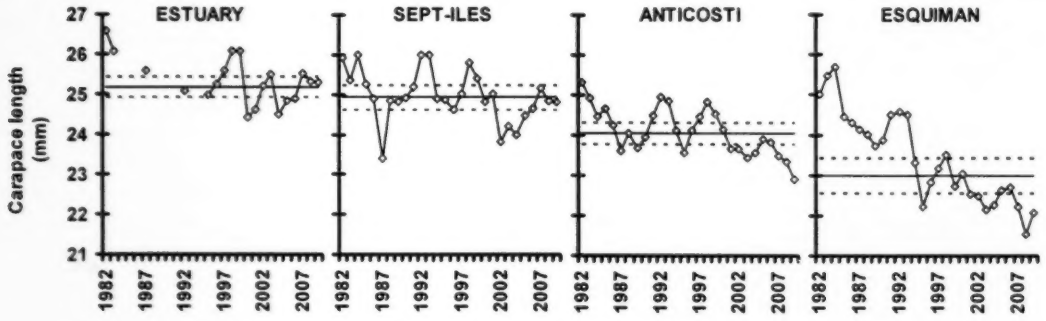


Figure 8. Mean size of females in summer by fishing area and by year. The full horizontal line represents the 1990-2008 mean ± 0.5 standard deviation.

Outlook

The 2004 year-class which dominated the male catches in Anticosti and Esquiman areas in 2007 contributed as females to the fishing success in 2009 (Figure 9). However, a proportion of this year class had already changed sex and had been recruited to the female component already in 2008 which explains the small sizes of females observed in 2008 and 2009 in these areas.

The 2005 year class (males of about 20 mm in 2009) that should contribute to the fishery in 2010 as primiparous females seems of average abundance in all areas except in Anticosti. On the other hand, the combined index for males and females gives an indication of the quantity of females that will be available to the fishery one year later. The index decreased in 2009 in Estuary, Sept-Iles and Esquiman and increased in Anticosti. It is likely that the fishing success in 2010 reflects the variations observed in this index.

The 2006 year-class seems to be more abundant than the average in all areas in 2008 and 2009 (Figure 9). The individuals of this year-class should contribute to the fishery as 4 year old males in 2010. They should change sex and be caught as primiparous females in 2011. These females will spawn in fall 2011 and should contribute to the spring fishing success in 2012, when the reproductive females are particularly targeted.

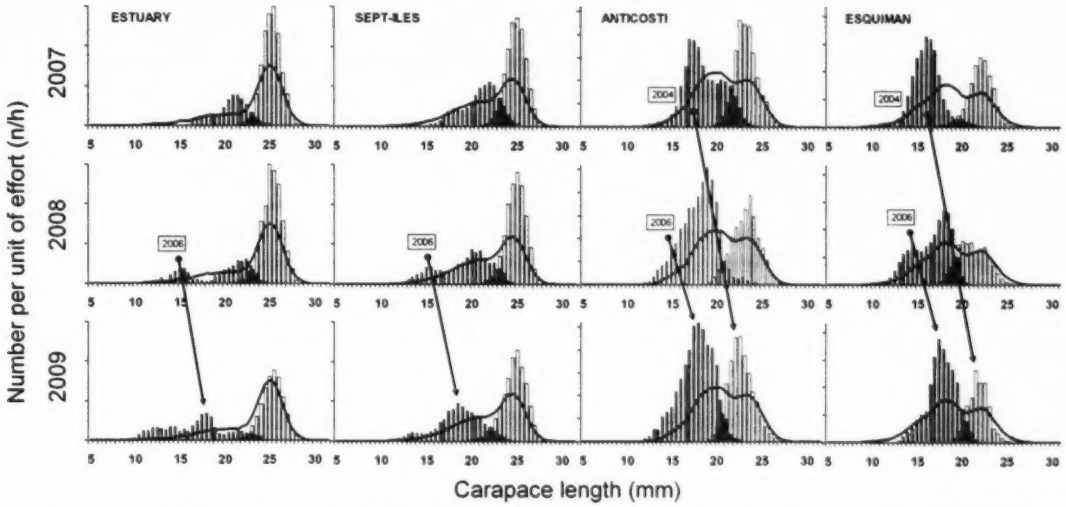


Figure 9. Catch rate from the commercial fishery (number per unit of effort) by length class and by fishing area from 2007 to 2009. The histograms represent males (dark) and females (pale) and the solid line represents the mean of the years 1990-2008.

Sources of Uncertainty

As was the case with many groundfish species, the indices of all components of the shrimp stocks (juveniles, males and females) increased simultaneously in the 2003 survey. It is possible that environmental factors could have had an impact on the availability to the trawl for shrimp of all the sizes which affected their catchability during that survey.

CONCLUSIONS AND ADVICE

The Sept-Iles, Anticosti and Esquiman stock status have been above the mean since 2003 and the female abundance is still in the healthy zone. In 2010, catches similar to those of 2009 should generate exploitation rates close to the historical mean. Consequently, the status quo is recommended for the 2010 TACs in these fishing areas.

The Estuary stock status decreased below the mean in 2009, the exploitation rate increased well above the mean and the female abundance came down in the precautionary zone. Consequently, a 10 to 15% decrease of the TAC is recommended for this fishing area in 2010.

The indicators for the Sept-Iles and Esquiman stocks seem however to indicate a decrease even if they are still in the healthy zone. It is thus important that the exploitation rates do not increase in order to help maintain these stocks in the healthy zone.

OTHER CONSIDERATIONS

By-catches of small fish in the shrimp fishery between 1999 and 2009 were examined from the at-sea observer database. Fish by-catches were predominantly in the range of 1 kg or less per species and per sampled tow. The presence of observers on board does not seem to disrupt the general fishing pattern since the shrimper catch rates with and without observers are similar. In general, by-catch of a given species varies between areas and years. The turbot, redfish and cod by-catches decreased in 2009 relative to 2008. In 2009, by-catches of the shrimp fishery represented catches of about 66 tons (0.9 million individuals) for turbot, 17 tons (0.4 million individuals) for redfish, 9 tons (0.1 million individuals) for cod and 301 tons (20.0 million individuals) for capelin.

The at-sea observer coverage percentage in use in the Gulf shrimp management plan (5%) has not been respected in the Esquiman area for six years and, was less than 2% in 2009. It is therefore recommended to increase the coverage by the observers in this area in order to insure an adequate monitoring of fishing operations in accordance with the measures indicated in the management plan.

SOURCES OF INFORMATION

Bourdages H., D. Archambault, B. Bernier, A. Fréchet, J. Gauthier, F. Grégoire, J. Lambert et L. Savard. 2010. Preliminary results from the groundfish and shrimp multidisciplinary survey in August 2009 in the northern Gulf of St. Lawrence. Can. Data Rep. Fish. Aquat. Sci. 1226 : xii + 72 p.

DFO. 2008. Proceedings of the Precautionary Approach Workshop on Shrimp and Prawn Canadian Stocks and Fisheries; November 26-27, 2008. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2008/031.

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